Position and Attitude Determination in Space with Autonomous Formation Flyer (AFF)

S. C. Wu, G. H. Purcell and D. Kuang

Jet Propulsion Laboratory
California Institute of Technology

As part of NASA's New Millennium Program, the Deep-Space 3 mission (DS-3) will fly two spacecraft in formation for the demonstration of various elements of technology required for space interferometry. One of the mission goal is to validate the Autonomous Formation Flyer (AFF) technology to a level that enables future separated (non-formation) spacecraft missions. The high-precision relative positioning capability of AFF will also support relevant sciences to be performed on DS-3.

The separation between DS-3's two spacecraft will vary between 40 and 1000 meters. The AFF system on each spacecraft will carry multiple transmitting and receiving antennas, enabling the acquisition of range and carrier phase data types. At the proposed Ka-band frequency, the expected data quality is 1 cm for range and 10 microns for carrier phase. With the multiple receiving antennas on each spacecraft, differential phase data type can be formed and precise relative attitude can be derived. The goal is to validate that the relative spacecraft positioning be determined to 1 centimeter and 2-D attitude to 1 arc-minute. Three-D relative attitudes can also be determined for a formation configuration consisting of 3 or more S/C.

This paper investigates the potential positioning accuracy of AFF with 2-S/C and 3-S/C formation configuration. Optimum tracking scenarios are searched to yield strongest positioning information. A phase ambiguity resolution scheme is studied. Resolving the ambiguities greatly strengthen the differential phase measurements and hence the relative attitude determination. Various implementation issues will be discussed.